# Space Weather Technical Forecast

Issued on Monday, 21 February 2022 at 13:15 Local

**This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales**

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**Space Weather Forecast Headline: Slight chance of G1/Minor Geomagnetic Storms day 1 into day 2 (21st/22nd). Slight chance throughout of M-class flares. Increasing Chance of Active fluence levels, mainly from day 3 (23 Feb) onward.**

**Analysis of Space Weather Activity over past 24 hours**

**Solar Activity:** Solar activity has been Very Low over the past 24 hours, with only minor flares recorded. Existing regions: AR2948, AR2952 and AR2953 have remained small and simple Alpha/Beta regions and have exhibited some signs of decay. During the past 24 hours 2 new regions have rotated round the northeast limb onto the visible disc. The first has been numbered AR2954 to be a mature but stable Hsx/Alpha region. The region following behind is still yet to come fully into view, but initially it also looks to be a Hsx/Alpha. However, this will need further analysis as it comes increasingly into view, as it is thought that this is the returning EX2938, which was the likely source of a notable far-sided flare and CME on the 15th.

No Earth-directed CMEs were observed in the available imagery during the past 24 hours.

**Solar Wind / Geomagnetic Activity:** The solar wind, as measured by DSCOVR at L1, has indicated that Earth has been experiencing the fast winds from a positive coronal hole, most likely CH56/+. The wind speed has been slightly elevated or elevated, ranging between 480 and 560 km/s. The density has been average or slightly above average, between 7 and 14 ppcc. The total magnetic field strength (IMF) Bt, has been weak (<8 nT), with the Bz fluctuating between -5nT and +7nT. The phi angle has been mostly positive (away from the Sun) throughout. Resultant geomagnetic activity was Quiet to Unsettled (Kp 1-3).

**Energetic Particles / Solar Radiation:** The high energy proton flux (10MeV) measured at GOES 16 has tracked slightly above background levels after a very large and energetic flare and CME from the far sided eastern solar hemisphere on the 15th February. The high energy electron flux (greater than 2MeV) has been at background levels. The corresponding 24-hour integrated electron fluence is steady and well below the Active (1e8 integrated pfu) threshold. The 21/0000 UTC observation was 2.06e6 pfu.

**Four-Day Space Weather Forecast Summary**

**Solar Activity:** Solar activity is likely to be Very Low or Low, but there is a slight chance of rising to Moderate levels through the 4 days due to the potential for flaring from the new regions emerging from the northeast limb. The other sunspot regions on the Earth-facing disc are currently unlikely to produce significant flares.

**Solar Wind / Geomagnetic Activity:** There are no Earth-directed CMEs in the forecast. Earth is experiencing a high speed stream from CH56/+, with this expected to persist during day 1 (21 Feb) and into day 2 (22 Feb), before gradually easing. Geomagnetic activity is expected to start Quiet to Unsettled, with a chance of Active intervals and slight chance of a G1/Minor Storm. However, this risk will reduce through the forecast period and activity is expected to become predominantly Quiet for days 3 and 4 (23rd and 24th).

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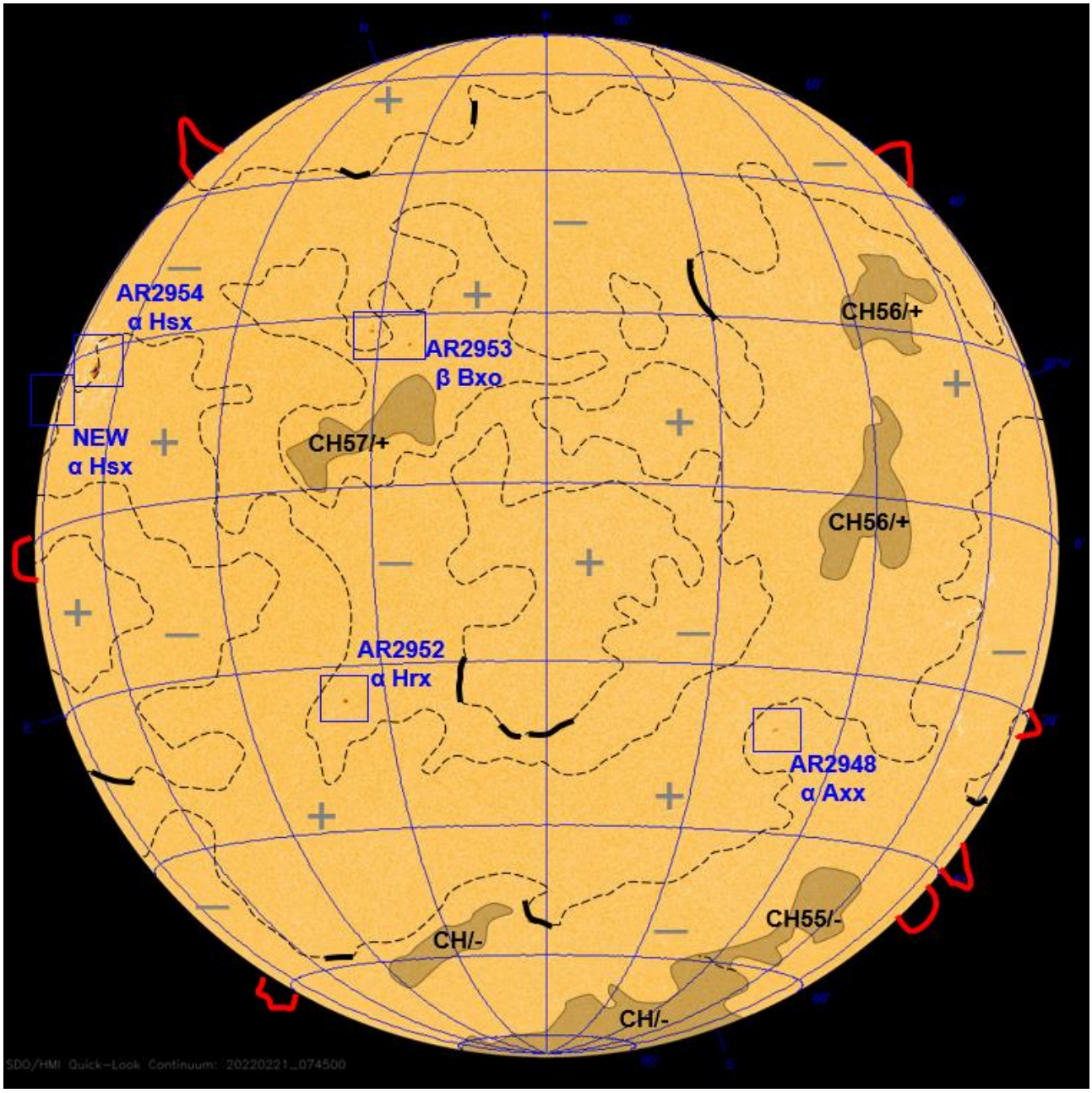
**Energetic Particles / Solar Radiation:** The high energy (greater than 10 MeV) proton flux is expected to fall to background levels and then persist at this level. The high energy (greater than 2 Mev) electron flux is currently at background, but may increase from day 2 (22nd) onwards, becoming Moderate with a chance of peaking at High (greater than 1000 pfu) levels. The associated fluence is also likely to rise, with a chance of exceeding the Active threshold (1e8 integrated pfu), most likely on day 4 (24 Feb).

**Figure 1. Solar Analysis Valid 21/0800 UTC.**




**Key:** Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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## Geomagnetic Storms:

There are no Earth-directed CMEs in the forecast, although there is a slight chance of weak CME effects on days 3 and 4 (23rd/24th) from a glancing blow from a filament lift off that occurred on the 19th.
Solar wind speeds are currently elevated, due to the high speed stream from CH56/+. They are expected to remain elevated over the next 24-36 hours, before gradually declining towards ambient levels through the remainder of the period as the effects of the coronal hole wane. Geomagnetic activity is expected to start Quiet to Unsettled, with a chance of Active intervals and slight chance of a G1/Minor Storm. However, this risk will reduce through the forecast period and activity is expected to become predominantly Quiet for days 3 and 4 (23rd and 24th).

| Geo-Magnetic Storm Probability (Exceedance) | Level | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) (%) | Day 2 (00-24 UTC) (%) | Day 3 (00-24 UTC) (%) | Day 4 (00-24 UTC) (%) |
|---|---|---|---|---|---|---|
| Minor or Moderate | G1 to G2 | No | 15 | 10 | 5 | 2 |
| Strong | G3 | No | 1 | 1 | 1 | 1 |
| Severe | G4 | No | 1 | 1 | 1 | 1 |
| Extreme | G5 | No | 1 | 1 | 1 | 1 |

## Geomagnetic Activity - Earthbound Coronal Mass Ejections

Nil.

## Radio Blackouts - X-Ray Flares:

There are currently five sunspot groups on the visible disc. The three older sunspots, AR2948, AR2952 and AR2953 are all relatively small and simple, with only a small flare risk. Over the past 24 hours two regions have rotated round the northeast limb. The first of which appears to be a mature but stable Hsx/Alpha region and has been numbered AR2954. The next region is still unnumbered and coming into view. It will require further analysis as it does, as it was this region that is thought to have been the source of an energetic flare and CME on the far side on the 15th.
Solar activity has been Very Low over the past 24 hours with only minor flares detected. It is likely to remain Very Low or Low through the forecast period but there is a slight chance of it increasing to Moderate, with M-class flares, as this new region rotates further onto the visible disc.

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| X Ray Flares | Level | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) | Day 2 (00-24 UTC) | Day 3 (00-24 UTC) | Day 4 (00-24 UTC) |
|---|---|---|---|---|---|---|
| Probability | | | (%) | (%) | (%) | (%) |
| Active | R1-R2 M Class | No | 10 | 15 | 20 | 20 |
| Very Active | R3 to R5 X Class | No | 2 | 2 | 2 | 2 |

## Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (10MeV) measured at GOES 16 has tracked slightly above background levels since 18/1200UTC. The enhanced activity was due to a very large and energetic flare and CME seen on coronagraph imagery from the rearward eastern solar hemisphere on the 15th. This region is due to rotate onto the Earth-side disc on day 1 (21 Feb), but has not exhibited any further significant activity since this flare. Furthermore, energetic protons are largely guided along the Parker spiral, and consequently radiation storms are notably less likely from the eastern limb for all except the largest flares. Until we can fully assess an ongoing flare risk from this region, the chance of proton storms (S1, which is greater than 10pfu) is maintained at background.

| Radiation Storms | Level ($cm^{-2}$ $sr^{-1}$ $s^{-1}$) | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) | Day 2 (00-24 UTC) | Day 3 (00-24 UTC) | Day 4 (00-24 UTC) |
|---|---|---|---|---|---|---|
| Probability (Exceedance) | | | (%) | (%) | (%) | (%) |
| Active | ≥ S1 | No | 1 | 1 | 1 | 1 |
| Very Active | ≥ S3 * | No | 1 | 1 | 1 | 1 |
| * S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$) | | | | | | |

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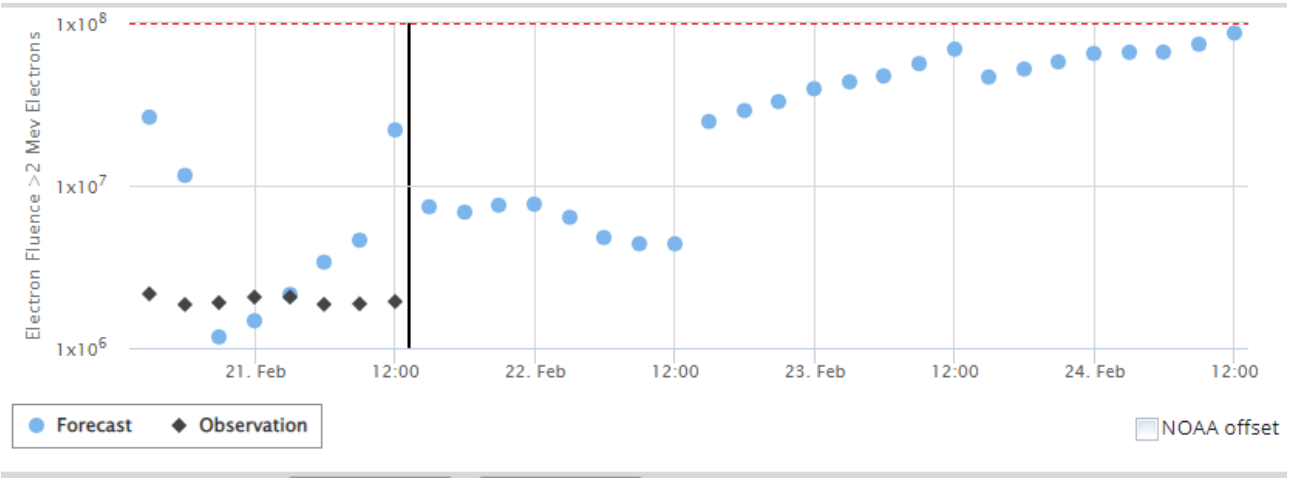
## High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2 MeV) as observed by GOES-16 at GEO is currently at background, having dropped out on the 19th. With solar winds rising to elevated levels due to CH56l, renewed electron charging is certainly possible. Electron flux may rise in the coming days, perhaps peaking at High levels (greater than 1000 pfu) from day 2 (22 Feb) onward. On Days 3 and 4 (23-24 Feb), more persistently Moderate to potentially High flux is possible.
The associated 24 hour Fluence is currently well below the Active threshold and on a flat trend. In response to the weakening of the solar wind and the recent charging event, there is a gradually increasing chance of Fluence levels becoming Active (>1e8 integrated pfu). REFM is showing an overall rising trend in electron fluence over the coming days and can be used as a rough guide for likely fluence values.

| GEO Electron Environment | Level ($cm^{-2}$ $sr^{-1}$ $day^{-1}$) | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) | Day 2 (00-24 UTC) | Day 3 (00-24 UTC) | Day 4 (00-24 UTC) |
|---|---|---|---|---|---|---|
| Probability (Exceedance) | | | (%) | (%) | (%) | (%) |
| Active | ≥ 2 MeV ≥ $1x10^8$ | No | 1 | 20 | 40 | 60 |
| Very Active | ≥ 2 MeV ≥ $1x10^9$ | No | 1 | 1 | 1 | 1 |

**Figure 2: GOES 16 observed electron fluence and REFM data**

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